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Quantifying the Impact of the Permanent Change of Station (PCS) Budget on Navy Enlisted Personnel Unit Readiness

Theodore J. Thompson
Iosif A. Krass
Timothy T. Liang

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The Navy spends over $600 million annually to move its active duty personnel. This report describes a model that relates permanent change of station (PCS) moves to personnel readiness. To support this model, a readiness measure which can distinguish among small differences in manning levels was developed. Using a hypothetical PCS move plan for a 5-month time horizon we show the effect of a reduced moving budget. The current move plan is for 17,300 moves while the reduced budget plan calls for 14,495 moves. The reduction in moves translates to a drop in readiness from 1.85 to 2.30.

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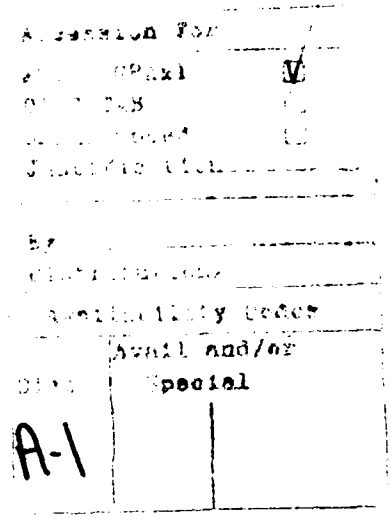

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Murray W. Rowe
Director, Manpower Systems Department

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APPENDIX

THE UR10 AND READY PROGRAMS

THE UR10 AND READY PROGRAMS

Data

Two data files, U1 and U2, maintained by the Enlisted Personnel Management Center (EPMAC) contain the manning and other information needed for readiness calculations.

U1 File

The U1 file contained personnel shortages to requirements and requirements (MOB+1) by activity, occupation, paygrade group, and time. Shortages are requirements minus on-board personnel. Activities are coded by unit identification code (UIC). Occupations are coded by rate code/Navy Enlisted Classification (RCN). This is the members' rating or when appropriate their Navy Enlisted Classification (NEC). NEC is Navy enlisted classification and stands for a specialized skill. MOB+1 is requirements within 1 month of an actual mobilization. The U1 file contains indicators to show which mission areas are affected by a given RCN. The file has a record for each UIC and RCN combination. Only UICs that are included in readiness calculations are in this file. We will refer to this set of UICs as readiness UICs. There are 906 UICs and 15,097 records in the U1 file used for this work. These counts will vary somewhat over time.

The U1 file *shortages to requirements* are actually shortages to a predefined percentage of requirements. Let s equal shortages to requirements, q equal requirements and b equal on-board personnel. The U1 file doesn't contain b, so it must be calculated as follows:

$s = 0.85q - b$ if paygrade group E-5 through E-9
$s = 0.90q - b$ if paygrade group E-1 through E-9
$b = 0.85q - s$ if paygrade group E-5 through E-9
$b = 0.90q - s$ if paygrade group E-1 through E-9

The manning percentage (m) for paygrade group E-5 through E-9 can be calculated by:

$$m = \frac{b}{q} \times 100 = \frac{0.85q - s}{q} \times 100$$

The manning percentage for paygrade group E-1 through E-9 is similarly calculated. The values 0.85 and 0.90 above correspond to the M-1 readiness rating. The U1 file also contains values of s corresponding to M-2 and M-3 readiness ratings. These values of s are contained in the U1 file instead of b to speed up interactive programs that use the U1 file.

U2 File

The U2 file contains personnel shortages to requirements and requirements by UIC and mission area. The shortages to requirements contained in this file are defined the same as in the U1 file above. The file has a record for each UIC and mission area. There are 19 mission areas. Only readiness UICs are included. The U2 file contained 4,616 records. This count will also vary over time.

UR10

UR10 is one of a series of readiness reporting programs currently available at EPMAC. For a given UIC, readiness level (C-1, C-2, or C-3), and time, UR10 calculates the number of people

required to reach the readiness level. Times allowed are current to 12 months into the future, in monthly increments. Input files to UR10 include the U1 and U2 files.

UR10 can be summarized in the following steps:

1. Determine the worst manning level among the mission areas for group paygrades E-5 to E-9 and then for group paygrades E-1 to E-9 (For the rest of this algorithm, these two groups shall be referred as Upper group and Lower group, respectively. Furthermore, the Upper group will always be processed ahead of the Lower group.)

2. Compare the levels obtained in step 1 with the respective minimum required levels of readiness given in each group. If both minimum levels are satisfied, go to step 8.

3. For the two groups, write out all mission areas that have not reached the minimum manning level.

4. For the worst manned mission area that does not satisfy the manning level requirements, determine the worst manned rating within the corresponding mission area.

5. Add a person to the rating obtained in step 4.

6. Update the manning levels that were affected by the change. Notice that changes in the Upper group will cause changes in the Lower group, but the converse is not true.

7. Write out the rating and the paygrades group for the new addition. Go back to step 1.

8. Stop.

Flowchart of program UR10 is shown in Figure A-1.

READY

READY, a FORTRAN program, was developed to calculate the demands of manpower for mission areas based on the continuous readiness measure. Unlike program UR10, READY calculates moves for all readiness activities in a single run and READY calculates total moves by readiness level, over a broad range of readiness levels, for all readiness UICs.

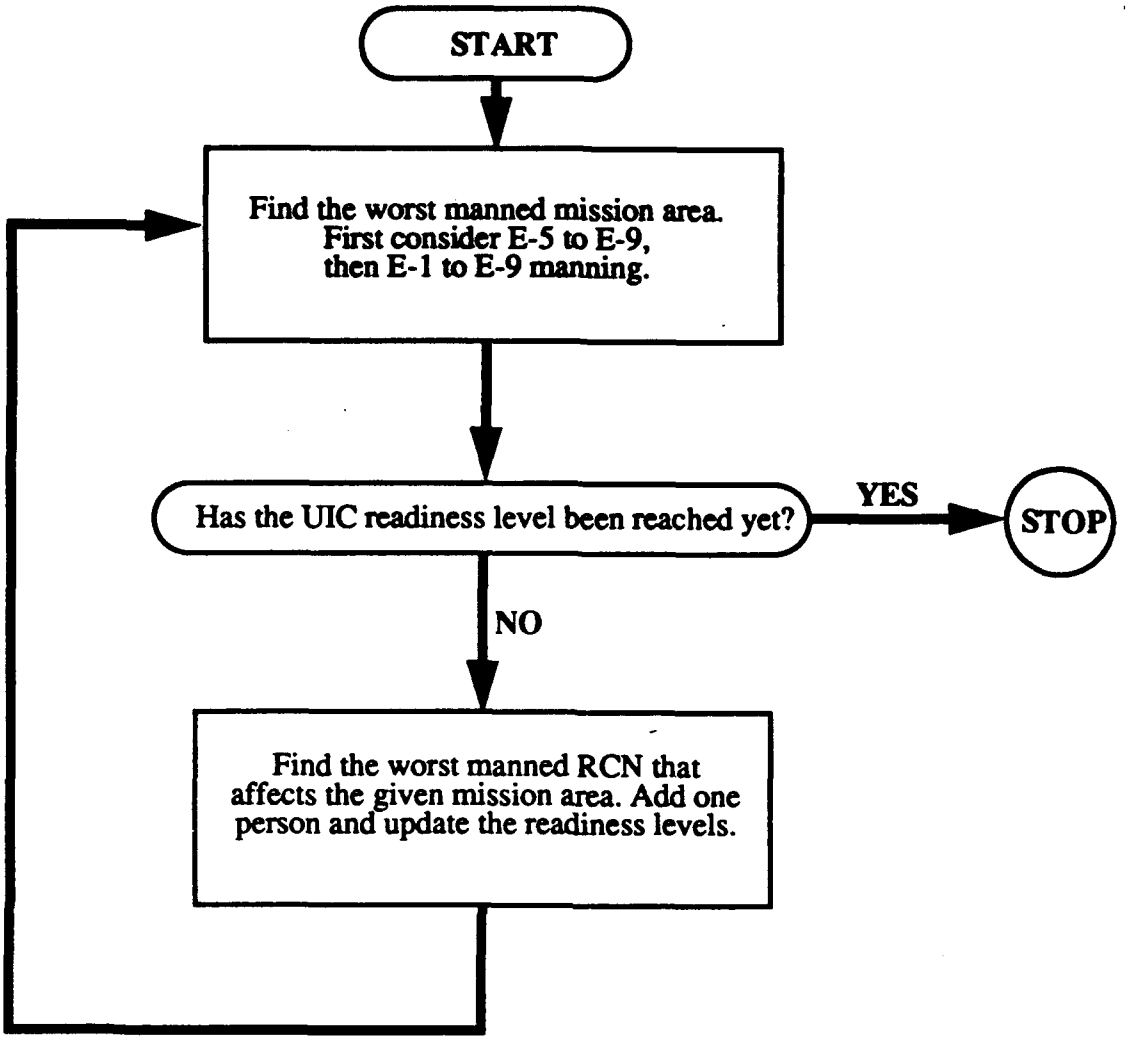
Program READY has input files U1 and U2. Also input to READY is the time parameter, t, ($t = 0, ..., 12$).

READY can be summarized in the following steps (See also the flowchart in Figure A-2.)

1. Determine all UICs with readiness level less than C-1 by finding the worst readiness level (r as defined in A New Continuous Readiness Measure (page 3)) among the mission areas for that UIC. Put these UICs in a table for sequential processing.

2. If the table is empty, go to step 5; otherwise, for the current UIC find the mission area with the worst readiness level.

3. Check if the UIC satisfies the readiness requirement. If true, the current UIC is finished. Go back to step 2 and process the next UIC on the list. If false, continue.



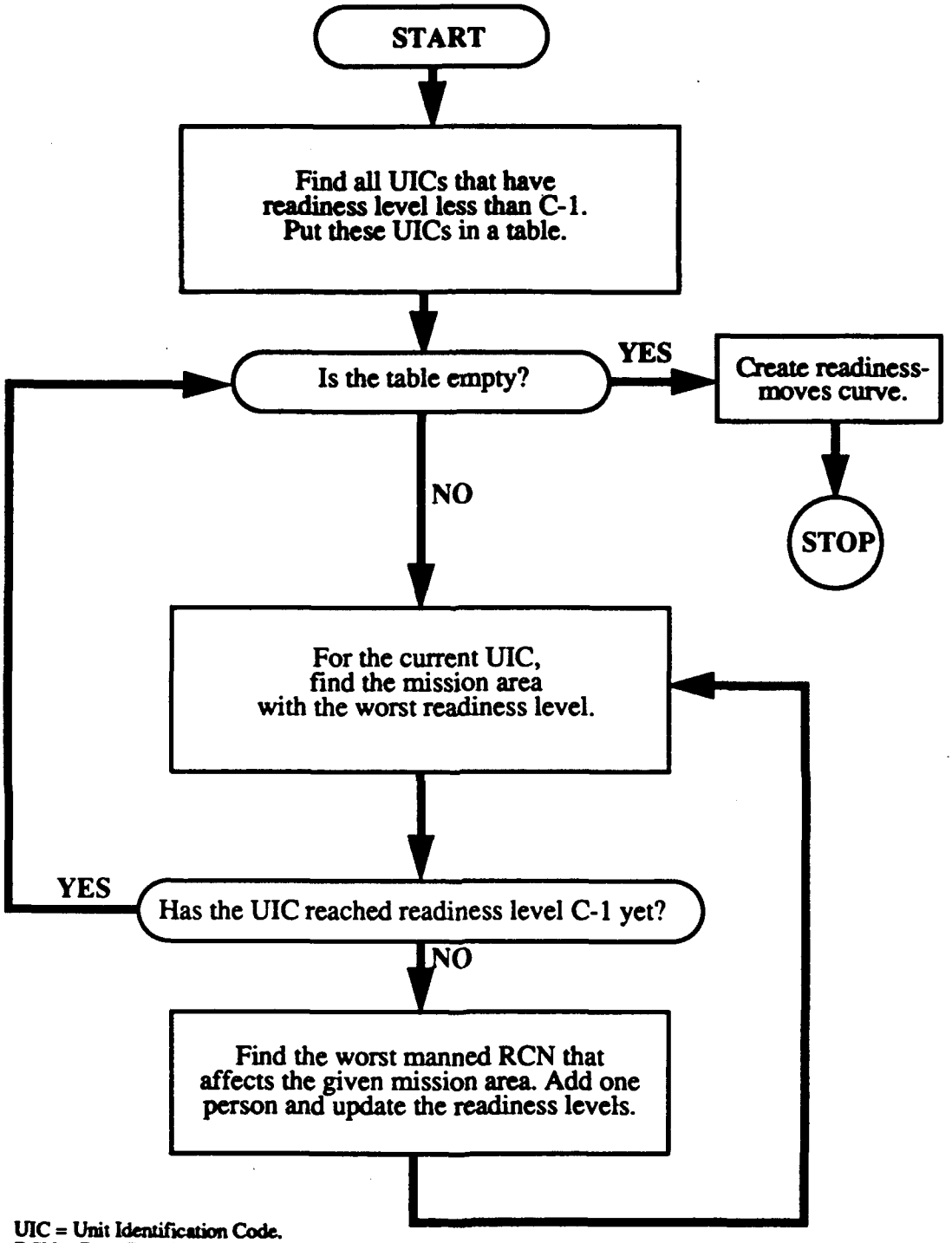
UIC = Unit Identification Code.
RCN = Rate Code/Navy Enlisted Classification (NEC).

Figure A-1. Flowchart of the UR10 program.

4. Find the worst manned RCN that affects the mission area. Add one person to this RCN by paygrade group. The paygrade group that has more impact on readiness is used. If there is a tie, the upper group gets the person. Update the changes caused by this additional person. Write out the RCN, mission area, and paygrades group for this move. Go back to step 2.

5. All UICs satisfy the readiness requirement; hence, create the cumulative readiness curve. Stop.

READY writes to an output file the table of UICs from step 1, together with its original readiness, the worst mission area and its manpower deficiencies for the two paygrades groups. The table is then sorted by UIC and mission area readiness. READY then accumulates the moves which improve the readiness from r to r-δ where δ is the step size of the curve (currently $\delta = 0.05$) and $r = 10, 10\text{-}\delta, 10\text{-}2\delta, \ldots, 1$. Information from each move is accumulated and kept in an internal table for producing the cumulative readiness curve. Then, READY will write this information to the output file. Finally, when all moves are decided, READY writes the cumulative readiness data to a second output file.



UIC = Unit Identification Code.
RCN = Rate Code/Navy Enlisted Classification (NEC).

Figure A-2. Flowchart of the READY program.

A flowchart of program READY is presented in Figure A-2. The program takes 2-3 minutes of CPU time and 2 megabytes of core storage to run on the Navy Personnel Research and Development Center IBM 4341.

FOREWORD

This report describes work performed during FY88 and FY89. The model described here was briefed and demonstrated to Bureau of Naval Personnel (PERS-40), (PERS-46), (PERS-47), and (PERS-23) in FY89. This report was originally prepared as part of program element 0603707N, work unit R1770-MP022 (PCS Control System), under the sponsorship of the Bureau of Naval Personnel (PERS-47). It is being published now to encourage use of this model by the Bureau of Naval Personnel (PERS-46). A draft version has been available since March 1989.

The objective of the project was to develop data based models to support permanent change of station moves planning.

Our thanks to Mike Yau for improvements to this report.

MURRAY W. ROWE
Director, Manpower Systems Department

SUMMARY

Problem

The Navy spends over $600 million annually to move its active duty personnel. Frequently, Navy fiscal planners and personnel managers have found it difficult to justify the portion of the permanent change of station (PCS) budget associated with training and rotation of members. Although methodology exists for forecasting future moves, managers have difficulty quantifying the impacts of an insufficiently-funded PCS budget. Justification of the PCS budget could be improved if moves could be linked to fleet personnel readiness.

Objective

This report describes a model that relates PCS moves to personnel readiness. To support this model, a readiness measure which can distinguish among small differences in manning levels was developed.

Approach

The existing methodology was limited by several problems. To remedy these problems, the current methodology was extended in three directions. First, all activities are modeled simultaneously. Second, a continuous personnel unit readiness measure, consistent with the current measure (C-rating) was developed. Third, an iterative model was developed that allocates moves based on improvements to readiness.

Results

The program was run using data from June 1988 and a 5-month time horizon. Using a hypothetical PCS move plan, the effect of a reduced moving budget was shown.

Conclusions

PCS moves can be related to personnel unit readiness using the methodology presented here. A program to perform this analysis was implemented on a personal computer. This program can be made available to distribution managers. The model could be extended in a number of directions. The definition of readiness could be expanded to cover all units. An "achievable" readiness model could also be developed to determine achievable readiness levels based on projected available personnel assets.

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INTRODUCTION

Problem

The Navy spends over $600 million annually to move its active duty personnel. The appropriation supporting these permanent change of station (PCS) moves pays for officer and enlisted accession, training, and separation moves, and for rotating members from one job to another. Frequently, Navy fiscal planners and personnel managers have found it difficult to justify the portion of the PCS budget associated with training and rotation of members. An established, detailed methodology for forecasting the number of future PCS moves based on planned and historical move behavior exists (Holmes & Pabiniak, 1989). Managers in the Distribution Management and Control Division (NMPC-46), the Distribution Support Division (NMPC-47), and the MPN Financial Management Department (NMPC-7) still have difficulty quantifying the impacts of an insufficiently-funded PCS budget. Justification of the PCS budget could be improved if moves could be linked to fleet personnel readiness

Objective

This report describes a model that relates PCS moves to personnel readiness. To support this model, a readiness measure which can distinguish among small differences in manning levels was developed.

Approach

The existing methodology for computing fleet personnel readiness at individual units (e.g., ships or squadrons) is plagued by several problems. First, calculations can only be made on one unit at a time. Second, the Navy measures fleet personnel readiness on a set of broad scales, known as C-ratings. For example, C-1 rating signifies that a unit is fully combat ready. A C-2 rating means substantially combat ready, and a C-3 rating means marginally combat ready, while a C-4 rating means not combat ready. Within these broad scales, a ship's manning (personnel/billets) can vary by nearly 10 percent, and not change the ship's C-rating. A more sensitive readiness measure is needed to account for the effects of PCS moves.

Finally, the problem includes complex resource allocation decisions. Fleet personnel readiness is measured using a unit's manning levels by mission area (e.g., mobility, antisubmarine warfare). A unit is given a C-rating based on its lowest mission area rating. There are up to nineteen mission areas possible and each mission area contains personnel in multiple occupations and skill levels. Therefore, a given occupation or skill level can contribute to the readiness of multiple mission areas. Determining the best way to allocate resources under these conditions is a difficult problem.

To remedy these problems, the currently available methodology (EPMAC, 1988) was extended in three directions. First, all units are modeled simultaneously. Second, a continuous personnel unit readiness measure, consistent with the current measure (C-rating) was developed.Third, moves are allocated to improve readiness iteratively. The model iteratively calculates required moves based on lowest manned occupation within lowest manned mission area for the unit with the worst personnel readiness.

MEASURING A UNIT'S READINESS

Definitions

Each combat unit must report its personnel readiness.[1] A unit's readiness is based on manning within its mission areas. *Manning* is defined as the percentage of requirements filled by on-board personnel. Readiness is measured for each mission area (M-rating) and for the entire unit (C-rating). The C-rating is equal to the minimum M-rating among the mission areas within the unit.

A unit's mission is to conduct operations. But, the mission can be broken down into several *mission areas*, such as mobility (MOB), anti-air warfare, submarine warfare, antisubmarine warfare, and amphibious warfare. The number of mission areas for different units varies. For example, an aircraft carrier has 10 mission areas, while a destroyer has 8. A mission area for a unit requires personnel with different attributes to support operational capabilities. The personnel attributes are characterized by skill (ratings and Navy Enlisted Classifications (NECs)) and experience (paygrades). A shortage of the necessary mission essential personnel degrades a mission area. For example, a unit's MOB mission area may consist of personnel from a few ratings. A shortage of personnel in any specified rating at specific paygrades would degrade the MOB mission area.

A mission area readiness rating (M-rating) is used to show a unit's capability to perform in that mission area. M-ratings range from M-1 (capable of effectively performing) to M-4 (severe deficiencies). The M-ratings are based on manning within paygrades E-1 through E-9 and E-5 through E-9. Table 1 shows the manning levels that are used to determine the M-rating for a mission area. The table shows, for example, that the M-rating for a unit is M-1 if the manning for paygrades E-1 to E-9 (collectively) is at least 90 percent *and* the manning for E-5 to E-9 is at least 85 percent. Manning levels for both the E-1 to E-9 group and the E-5 to E-9 group need to be satisfied. If E-1 to E-9 manning is 90 percent, while the E-5 to E-9 manning falls to say, 80 percent, then the mission area is classified as M-2. Note that the manning levels for E-1 to E-9 and for E-5 to E-9 are not mutually exclusive. A member at E-5 and above is counted in both groups. This indicates that the personnel at E-5 and above have a greater impact on determining the M-rating than those at E-4 and below. Additional information about the current readiness measure is contained in an earlier report (Liang, 1987).

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[1]Joint Chiefs of Staff (JCS) requires combat readiness reporting. The Chief of Naval Operations (OP-06) defines which Navy units require personnel readiness reporting.

Table 1

Criteria to Determine M-ratings

Mission Area Readiness Rating (M-rating)	If Manning for Paygrades E-5 through E-9	If Manning for Paygrades E-1 through E-9
M-1	85% and above	90% and above
M-2	75%-84%	80%-89%
M-3	65%-74%	70%-79%
M-4	less than 65%	less than 70%

A New Continuous Readiness Measure

The M-ratings are relatively insensitive to small changes in manning levels. For example, if E-5 through E-9 manning is 75 percent and E-1 through E-9 manning is 80 percent, the current readiness measure is M-2. Yet, if the E-5 through E-9 manning is increased to 84 percent and E-1 through E-9 manning is increased to 89 percent, the current readiness measure remains M-2.

To overcome this problem a continuous readiness measure was defined as follows:

Let x be the paygrade E-5 to E-9 manning percentage and y be the E-1 to E-9 manning percentage, then the new readiness level r is:

$$r = 10 - \frac{\min[(x + 5), y]}{10}$$

The current readiness measure (M) can be defined in terms of r as follows.

$$M = \begin{cases} 1 & \text{if } r \leq 1 \\ 2 & \text{if } 1 < r \leq 2 \\ 3 & \text{if } 2 < r \leq 3 \\ 4 & \text{if } r > 3 \end{cases}$$

Again, a unit's readiness is equal to the lowest readiness level among its mission areas.

The continuous measure, r, is shown graphically in Figure 1. The shaded areas in the figure show readiness as defined in Table 1. The continuous measure can be thought of as a "distance" along the line l. The distance is measured from the upper right end of line l, marked 0, to the spot where a point, p, projects onto line l. The projection is a horizontal line if p is to the right of line l and a vertical line if p is to the left of line l. For example, if E-1 through E-9 manning is 75 percent and E-5 through E-9 manning is 85 percent, then p = (85,75). The projection of p onto line l is (70,75). The distance along line l, the readiness level, is 2.5. The units of measure for readiness are marked on line l.

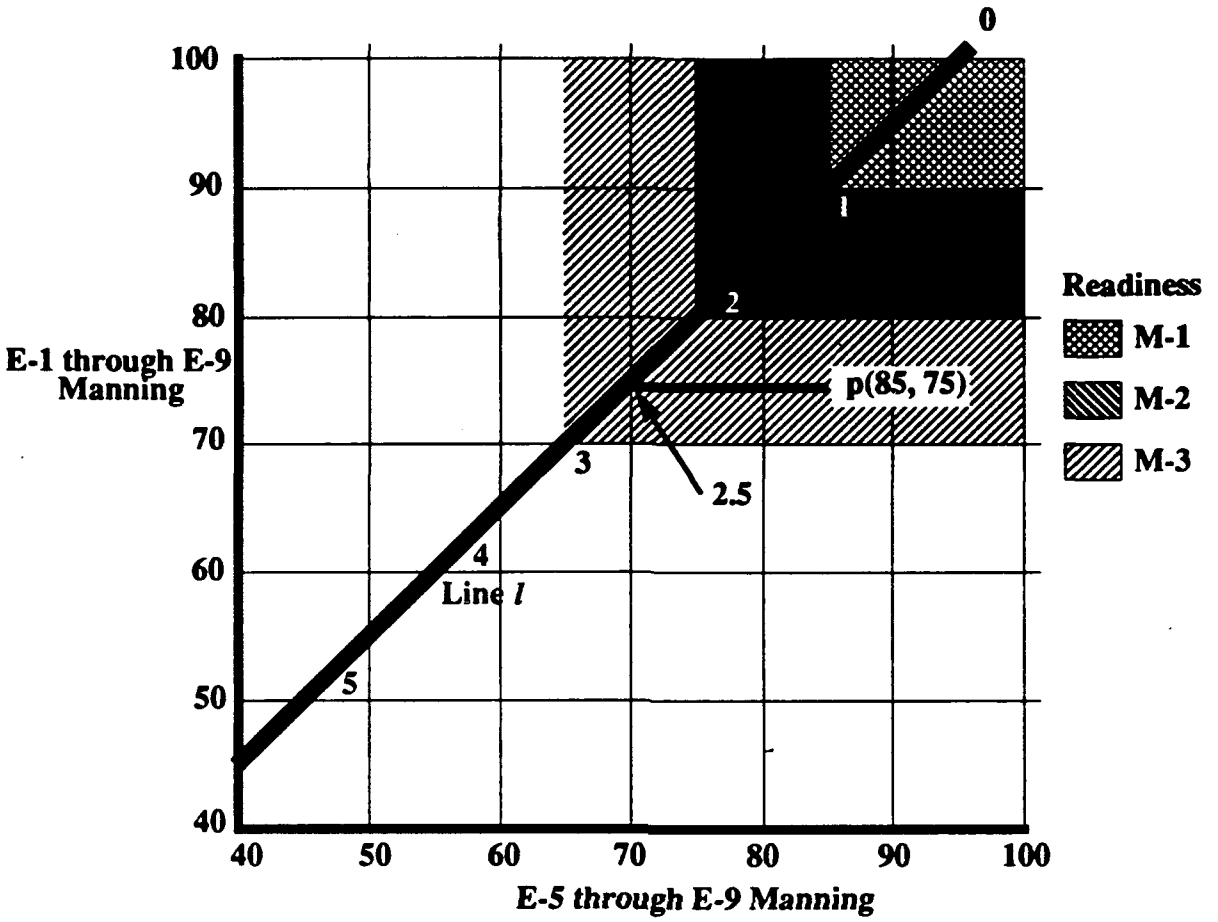

Figure 1. Graphical description of the continuous readiness measure.

The current, discrete measure and the continuous readiness measure are compared for various manning levels in Table 2. Using our original example, the table shows that if E-5 through E-9 manning is 75 percent and E-1 through E-9 manning is 80 percent, the current readiness measure and the continuous measure are both M-2. However, if the E-5 through E-9 manning is 84 percent and E-1 through E-9 manning is 89 percent, the current readiness measure remains M-2, while the continuous measure shows significant improvement, to 1.1.

COMPUTING MOVES TO ACHIEVE READINESS

Data

Two data files, U1 and U2, maintained by the Enlisted Personnel Management Center (EPMAC) contain manning and other information needed for readiness calculations.

Table 2

Comparison of Readiness Measures (M-ratings)

Manning		Continuous Measure	Current Measure
E-5 through E-9	E-1 through -9		
85	90	1.0	1
84	89	1.1	2
83	88	1.2	2
82	87	1.3	2
81	86	1.4	2
80	85	1.5	2
79	84	1.6	2
78	83	1.7	2
77	82	1.8	2
76	81	1.9	2
75	80	2.0	2
74	79	2.1	3
73	78	2.2	3
72	77	2.3	3
71	76	2.4	3
70	75	2.5	3
69	74	2.6	3
68	73	2.7	3
67	72	2.8	3
66	71	2.9	3
65	70	3.0	4
64	69	3.1	4
63	68	3.2	4
62	67	3.3	4
61	66	3.4	4
60	65	3.5	4
59	64	3.6	4
58	63	3.7	4
57	62	3.8	4
56	61	3.9	4
55	60	4.0	4

The U1 file contains personnel shortages and requirements[2] by unit, occupation, paygrade group, and time horizon (1 to 12 months into the future). Shortages are requirements less on-board personnel. Units are identified by unit identification code (UIC). Occupations are coded by Rate Code/NEC (RCN), which is a rating or when appropriate an NEC. The U1 file contains indicators to show which mission areas are affected by a given RCN. The file has a record for each UIC and RCN combination. Only UICs included in readiness calculations (e.g. combat units) are maintained in this file.[3]

[2]MOB+1, requirements within 1 month of mobilization, is used.

[3]During this study, the U1 file contained 906 UICs and 15,097 records.

The U2 file contains personnel shortages and requirements by UIC and mission area. The file has a record for each UIC and mission area.[4]

UR10 Program

UR10 is one of a series of readiness reporting programs currently available at EPMAC. For a given UIC, desired readiness level (C-1, C-2, or C-3), and time horizon, UR10 calculates the number of people required to move to achieve the readiness level. The U1 and U2 files are input to the UR10 program.

READY Program

READY was developed to calculate the manpower demands of mission areas based on the continuous readiness measure. Unlike the UR10 program, READY calculates moves for all readiness activities simultaneously. The model computes the total number of moves needed to achieve a broad range of readiness levels.

Like the UR10 program, READY also uses files U1 and U2 as input and focuses on moves for any desired time horizon within the next 12 months. READY accumulates the moves which improve the readiness from r to r-δ where $\delta = 0.05$ and $r = 10, 10\text{-}\delta, 10\text{-}2\delta, \ldots, 1$. Information by unit and mission area is kept in an internal table for producing the cumulative readiness curve.

A more complete description of the UR10 and READY programs is provided in the Appendix.

RESULTS

The READY program was run using data (U1 and U2 files) from June 1988 and a 5-month time horizon. Assuming 75 percent of total moves are cost moves,[5] results are plotted in Figure 2. Over 8,000 moves during the period June–October 1988 would have been necessary to bring all units up to readiness level 1.

Analysis

The READY model can be used to estimate impacts on readiness from reductions in the number of PCS moves. Table 3 shows a hypothetical PCS move plan for a 5-month period. For each type of move, the table shows average cost per move, currently planned moves and their cost, as well as reduced budget moves and their cost. Moves are classified as operational (between sea duty and shore duty within the continental U.S.), rotational (between overseas and the continental U.S.), and training (long-term training).

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[4] There are 19 mission areas. During this study the U2 file contained 4,616 records.

[5] Whenever a member moves between units more than 50 miles apart, it is considered a cost move. The 1988 cost, no cost breakdown was approximately 75 percent, 25 percent. This figure does not affect the methodology. Whatever figure is appropriate can be used in the future.

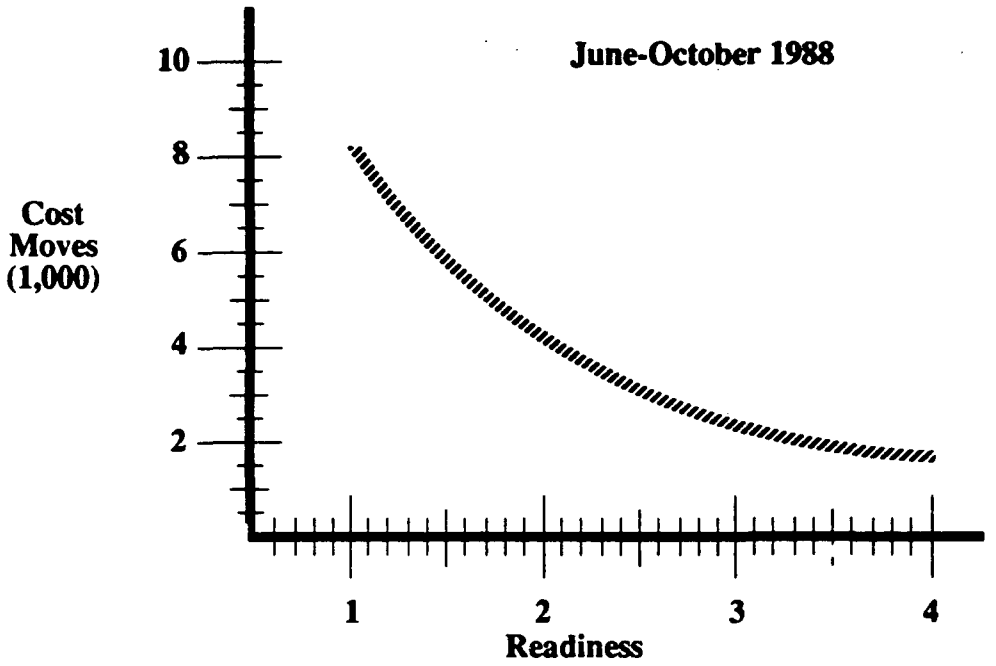

Figure 2. Permanent change of station cost moves by fleet personnel readiness.

Table 3

Permanent Change of Station Move Plan Under the Current and Reduced Budgets

Type of Move	Cost per Move	Current Budget		Reduced Budget	
		Moves	Cost ($M)	Moves	Cost ($M)
Operational	$2400	10,500	$25.2	7,875	$18.9
Rotational	$4400	1,800	$7.9	1,620	$7.1
Training	$1200	5,000	$6.0	5,000	$6.0
Total		17,300	$39.1	14,495	$32.0

In this example, the current budget is $39.1 million, while the reduced budget is $32.0 million. The current move plan is for 10,500 operational, 1,800 rotational, and 5,000 training moves. The reduced budget plan calls for 7,875 operational, 1,620 rotational, and 5,000 training moves.

Not all moves in the move plan affect readiness. Personnel readiness in not defined for all units including most shore units. The percentage of moves affecting readiness was estimated from historical billet and personnel data and are displayed in Table 4. Multiplying these percentages by the number of moves in Table 3 gives the number of moves affecting readiness under both the current budget and reduced budget move plans. The unit readiness moves are shown in Table 5. The reduction in moves translates to a drop in readiness from 1.85 to 2.30.

Table 4

Percent of Moves Affecting Readiness

Type of Move	Percent
Operational	38%
Rotational	25%
Training	0%

Table 5

Unit Readiness Moves and Readiness Rating

	Unit Readiness Moves	
Type of Move	Under the Current Budget	Under the Reduced Budget
Operational	3990	2993
Rotational	450	405
Training	0	0
Total	4440	3398
Readiness	1.85	2.30

CONCLUSIONS

PCS moves can be related to personnel unit readiness using the methodology presented here. A program to perform the analysis was implemented on a personnel computer. This could be made available to distribution managers.

The program could be extended in a number of directions. The definition of readiness could be expanded to cover all units. Most shore based units are not included in readiness calculations. An "achievable" readiness model could also be developed to determine achievable readiness levels based on projected available personnel assets. There are, currently, Navy data systems that project personnel supply. The model presented in this report could provide the demand for moves.

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